Study of Building Structure with Varying Design of Slabs

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Abstract- The present objective of this work is to compare between behavior of flat slab with waffle or grid slab using in high rise buildings in different geometry. For this analysis there are taken 18 models of Rectangular, Pentagonal and Octagonal geometry having different floors as 8, 16 and 24. The parametric studies comprise of maximum nodal displacement, maximum share force, storey drift maximum beam moment and axial forces generated in the beam and column. The modelling is done in STAAD.pro V8i for seismic zones IV. The Plan size of rectangle geometry 16X28 m, Octagonal geometry 16 m in diameter, and octagonal geometry 12 m in diameteris considered. The height of floors is taken 3.2 meter. Seismic loadings are considered separately to evaluate the performance of all the 18 models and conclusions have drawn on the best framing system. On the basis of the seismic behaviour, the performance of the structure is checked, and then after finally the additional required measures and concepts for the design of structure for the improvement are suggested. This study gives various information of seismic parameters like storey drift, maximum beam moment seismic, behaviour, base shear and maximum share force based on current literature review.

Keywords:Flat Slab, waffle or grid Slab, RCC Structure Design& STAAD.pro V8i

I. INTRODUCTION

Due to urbanization and increasing population in our country there is a growing demand for high-rise buildings. Earthquake and wind load are the biggest problem for such buildings. Due to its unpredictability and the huge power of destruction, earthquake is the most destructive. Earthquakes do not kill themselves, but there is a huge loss of human life and properties are caused by the destruction of structures.

The aim of this paper is to conduct analysis of the RCC building frames under seismic loading and wind loading condition and to check the change in structural behavior due to such loading. Earthquake loads for building structures are one of the important design loads. In the previous research project on high building structures, the study of the demands of air-pressure have been classified as follows: reactions on the cross and accompanying air pressure. These demands are due to various mechanisms. Due to the effect of unrest caused by the wind, the direct component is related to the effect of the windstorm. On the other hand, the impact of wind load on tall structures is not only distributed on the wider surface, but also its intensity is high.

II. IMPLEMENTATION

Problem Statement

8, 16 &24 storied building models are designed using flat slab &waffle/gride slab in rectangular, pentagonal and octagonal geometry respectively. Then these models are analyzed for dead load, live loadand seismic load. Dead load was designed according to IS: 875-1987(Part 1) and Seismic load was designed using response spectrum method for earthquake zone III of India using IS: 1903-2002. Wind analysis was done according to IS: 875-1987 (Part3). The details of the modeled building are listed below. Modal damping of 5% is considered with SMRF and Importance Factor (I) =1.

To create a design member, use the Normal Cursor (also known as Elements Cursor) to select one or more analytical beams, then click on the menu item Member>Form Member. Information on Design Members can be selected using the Members Cursor. Details of design members can be seen in the Members Table.

To delete a design member, use the Members to select it and press 'Delete' on the keyboard or from the Edit menu.

Note that an analytical beam segment can only be part of one design member definition.

Design members can be designed with either Beam or Column Design Briefs.

To create a design slab, use the Plates Cursor to select one or more finite elements, then click on the menu item Slabs>Form Slab. Information on design slabs that have been created is listed in the Slabs Table

Assumptions:-

- The accompanying suppositions were made before the beginning of the demonstrating technique in order to keep up comparable conditions for all the three models:

- Only the primary piece of the building is considered. The staircases are not considered in the plan methodology.
- The building is utilized for displays and along these lines interior dividers are not given.
- Only outer dividers 230 mm thick with 12 mm mortar on each side will be given. However in the present examination, just the edge is considered and thus, dividers are not given.
- At ground floor, chunks are not given and the plinth is resting 1m over the ground.
- The shafts are laying midway on the segments in order to dodge the states of erraticism.
- For every single auxiliary component, M-25 and Fe-415 are utilized.
- The footings are not outlined. Backings are appointed as settled backings.
- Seismic loads are considered in the flat bearing just and the vertical heading are thought to be irrelevant.
- Sizes of the individuals are as per the following: (All measurements are in mm)

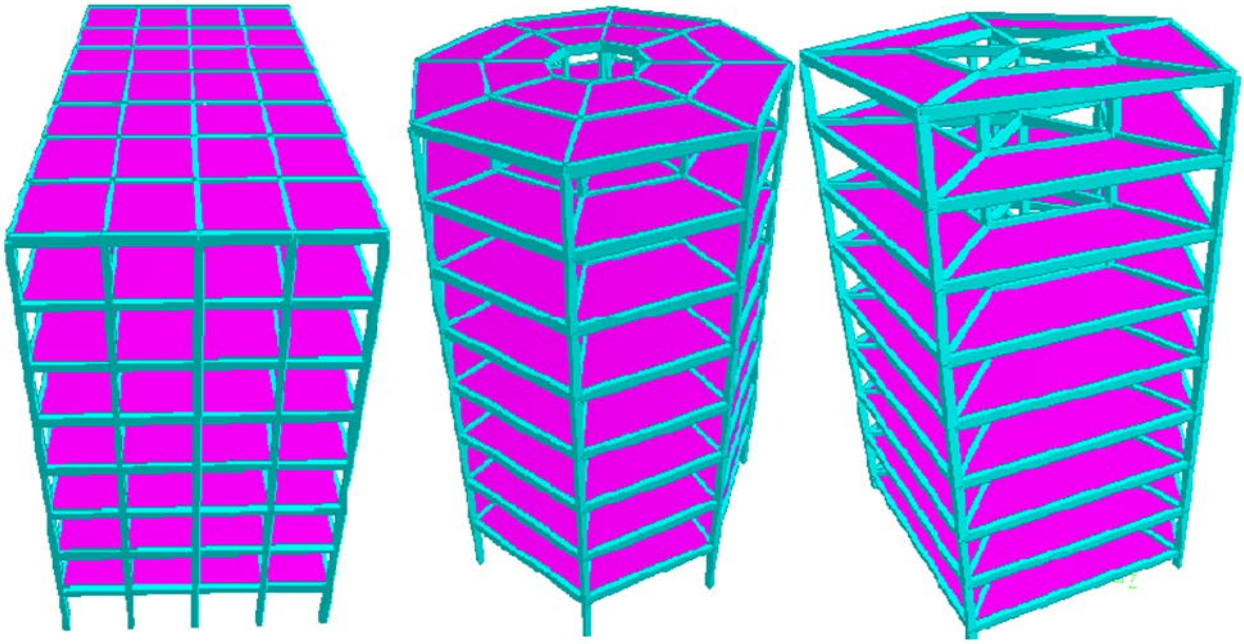

Fig. 3.2. – Generated models of Rectangular, Octagonal and Pentagonal Structures of 8th storey with Waffle Slab System

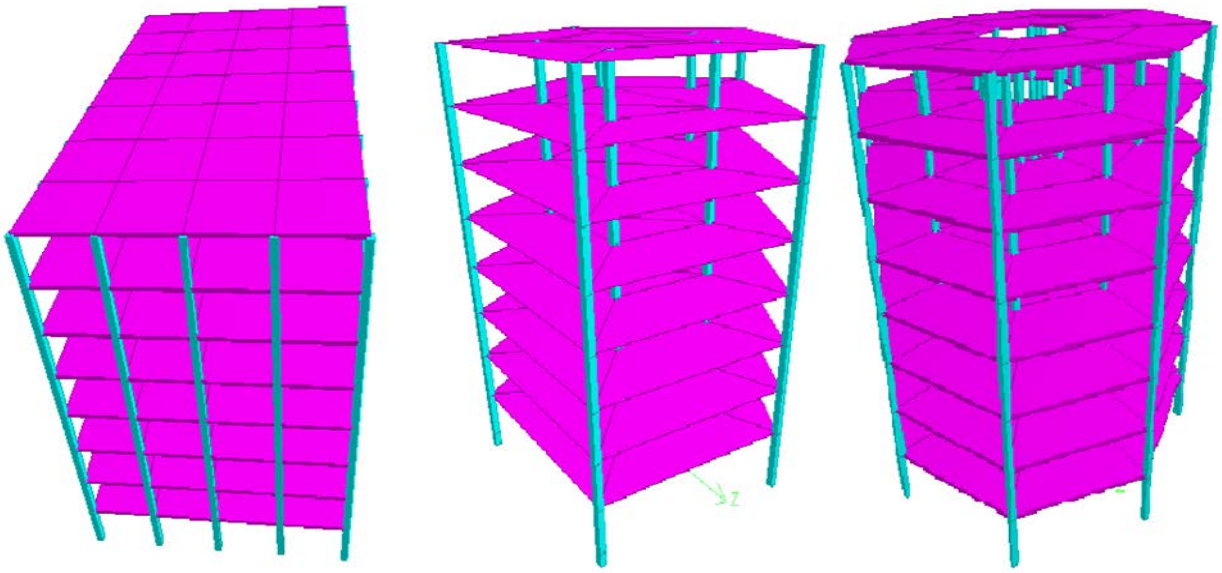

Fig. 3.3. – Generated models of Rectangular, Pentagonal and Octagonal Structures of 8th storey with Flat Slab System

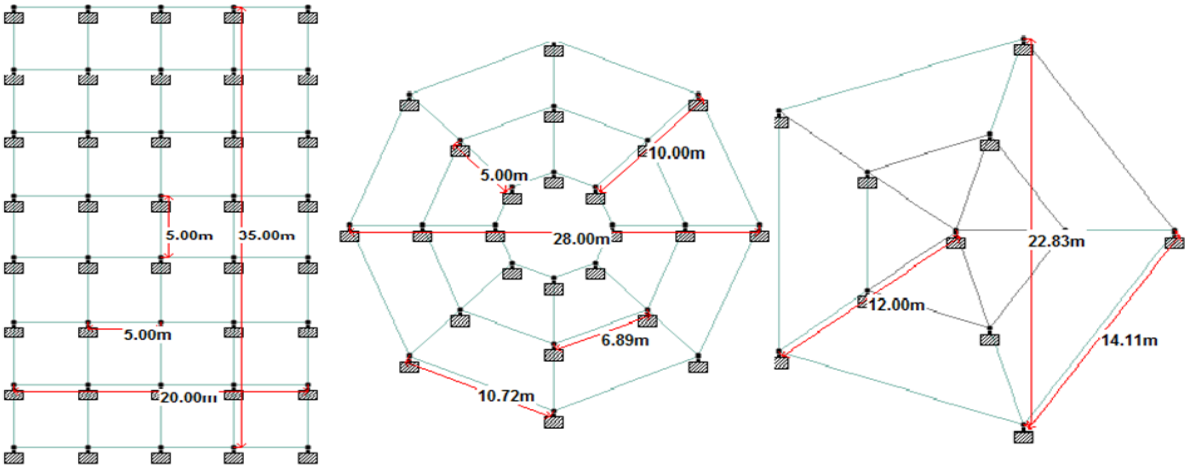

Fig. 3.4. – Basic Plan of the models of 8th storey

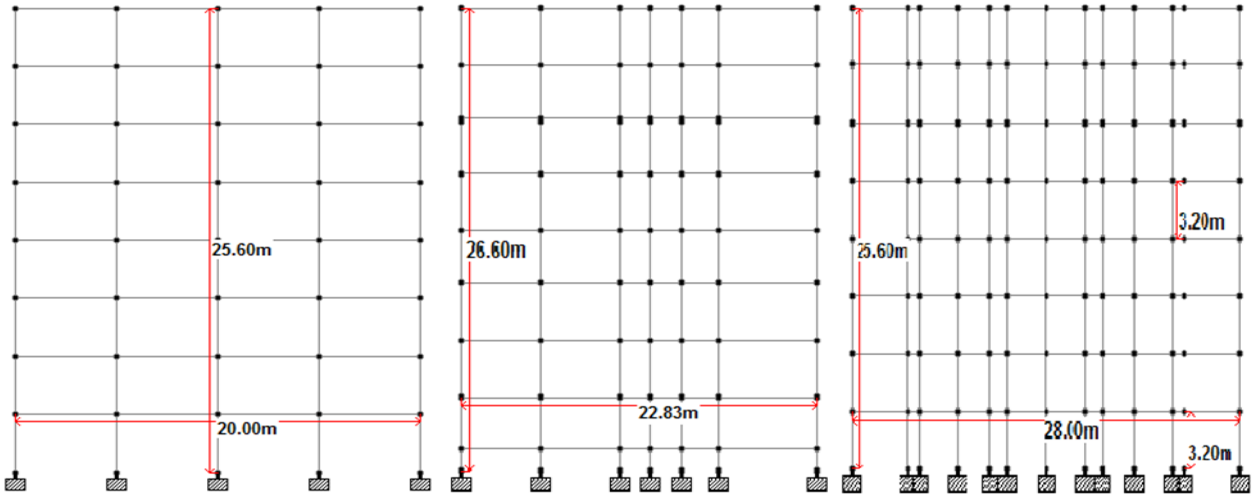

Fig. 3.5. – Basic Plan &Elevation of the models of 8th storey

Table 3.2 - Specifications for various Models

S.No	Specifications	Type of Building Geometry		
		Rectangle	**Hexagonal**	**Octagonal**
1	Plan dimensions	20 m × 35 m (X×Z)	12 m (Radius)	14 m (Radius)
2	Length in X- direction	20 m	24 m	28 m
3	Length in Z- direction	35 m	24 m	28 m
4	Floor to floor height	3.2 m	3.2 m	3.2 m
5	No. of Stories	8, 16 & 24	8, 16 & 24	8, 16 & 24
6	Total height of Building	26,51&77 m	26,51 &77 m	26,51 &77 m
7	Slab Thickness for flat slab	200 mm	200 mm	200 mm
8	Soil Type	Hard	Hard	Hard
9	Grade of concrete	M 25	M 25	M 25
10	Grade of Steel	Fe 415	Fe 415	Fe 415
11	Beam =08G storey structure	0.45 m x 0.3 m	0.45 m x 0.3 m	0.45 m x 0.3 m
	=16G storey structure	0.5 m x 0.3 m	0.53 m x 0.3 m	0.53 m x 0.3 m
	=24G storey structure	0.6 m x 0.3 m	0.6 m x 0.3 m	0.6 m x 0.3 m
12	**Column** =08Gstorey structure	0.4 m x 0.23 m	0.4 m x 0.23 m	0.4 m x 0.3 m
	=08Fstorey structure	0.45 m x 0.3 m	0.45 m x 0.3 m	0.45 m x 0.4 m

	=16Gstorey structure	0.6 m x 0.4 m	0.6 m x 0.4 m	0.6 m x 0.4 m
	=16F storey structure	0.6 m x 0.45 m	0.6 m x 0.45 m	0.6 m x 0.45 m
	=24Gstorey structure	0.6 m x 0.5 m	0.7 m x 0.5 m	0.7 m x 0.6 m
	=24F storey structure	0.8 m x 0.5 m	0.9 m x 0.6 m	0.8 m x 0.6 m
13	Location	Seismic Zone IV	Seismic Zone IV	Seismic Zone IV
14	Live Load on Slabs	4.5kN/m^2	4.5kN/m^2	4.5kN/m^2

III. ANALYSIS AND RESULTS

Various components of traditional slab structure and flat slab structure with different masonry are as follows:

- ✓ Grade of concrete = M25
- ✓ Grade of steel Fe = 415
- ✓ Beam size of 8 Storey structure = 450 mm x 30 mm
- ✓ Beam size of 16 Storey structure = 500 mm x 300 mm
- ✓ Beam size of 24 Storey structure = 600 mm x 300 mm
- ✓ Column size of 8 Storey flat floor structure = 450 mm x 300 mm
- ✓ Column size of 16 Storey flat floor structure = 450 mm x 400 mm
- ✓ Column size of 24 Storey flat floor structure = 600 mm x 450 mm
- ✓ Column size of 8 Storey conventional slab structure = 600 mm x 450 mm
- ✓ Column size of 16 Storey conventional slab structure = 600 mm x 600 mm
- ✓ Column size of 24 Storey conventional slab structure = 600 mm x 500 mm
- ✓ Slab thickness of the waffle structure = 150 mm
- ✓ Flat slab thickness = 200mm

The accompanying parameters were considered to introduce an examination between the distinctive casings:

- ✓ Maximum Beam Shear
- ✓ Maximum Beam Moments
- ✓ Maximum Nodal Deflections

IV. RESULTS AND DISCUSSION

5.1 Maximum Beam stresses:-A comparison report between different geometries is given in the table.

Table 5.1– Comparison of Beam Shear

No. of Stories	Geometry	Model No.	Type of Slab	Max Fx (in kN)	Max Fy (in kN)	Max Fz (in kN)
8	Rectangle	RECT-08G	Waffle Slab	3848.942	39. 192	37.768
		RECT-08F	Flat Slab	3447.066	29.484	23.703
	Pentagonal	PENT -08G	Waffle Slab	5372.840	49.960	39.393
		PENT -08F	Flat Slab	4582.180	40.312	29.899
	Octagonal	OCT-08G	Waffle Slab	5092.030	38.169	29.127
		OCT-08F	Flat Slab	3658.951	29.901	25.671
	Rectangle	RECT-16G	Waffle Slab	17863.095	55.845	37.958

16		RECT-16F	Flat Slab	14175.429	60.329	21.245
	Pentagonal	PENT -16G	Waffle Slab	9978.805	61.109	55.920
		PENT -16F	Flat Slab	4811.309	39.740	30.308
	Octagonal	OCT-16G	Waffle Slab	9871.608	51.510	54.159
		OCT-16F	Flat Slab	7421.209	47.198	40.860
24	Rectangle	RECT-24G	Waffle Slab	18246.522	91.290	75.970
		RECT-24F	Flat Slab	16789.119	95.479	56.907
	Pentagonal	PENT -24G	Waffle Slab	14548.416	134.779	70.506
		PENT -24F	Flat Slab	13867.307	81.609	71.019
	Octagonal	OCT-24G	Waffle Slab	15358.602	79.776	61.805
		OCT-24F	Flat Slab	14624.978	67.209	59.608

5.2 Maximum Beam Moments: A comparison report between different geometries is given in the table.

Table 5.2 – Comparison of Beam Moments

No. of Stories	Geometry	Model No.	Type of Slab	Max Mx (in kNm)	Max My (in kNm)	Max Mz (in kNm)
8	Rectangle	RECT-08G	Waffle Slab	0.518	61.102	67.602
		RECT-08F	Flat Slab	0.793	49.420	53.561
	Pentagonal	PENT -08G	Waffle Slab	2.905	96.966	117.547
		PENT -08F	Flat Slab	0.199	84.302	95.485
	Octagonal	OCT-08G	Waffle Slab	3.107	65.062	78.539
		OCT-08F	Flat Slab	0.971	56.901	71.898
16	Rectangle	RECT-16G	Waffle Slab	0.902	70.855	178.805
		RECT-16F	Flat Slab	1.075	57.374	192.439
	Pentagonal	PENT -16G	Waffle Slab	3.263	148.896	189.825
		PENT -16F	Flat Slab	0.798	76.409	137.306
	Octagonal	OCT-16G	Waffle Slab	2.741	113.525	196.898
		OCT-16F	Flat Slab	0.563	51.108	158.229
24	Rectangle	RECT-24G	Waffle Slab	0.178	169.290	266.501
		RECT-24F	Flat Slab	1.079	99.420	300.190
	Pentagonal	PENT -24G	Waffle Slab	3.596	138.469	187.745
		PENT -24F	Flat Slab	2.169	128.602	169.497
	Octagonal	OCT-24G	Waffle Slab	3.240	151.736	162.602
		OCT-24F	Flat Slab	0.951	126.291	169.270

5.3 Maximum Nodal Deflection: A comparison report between different geometries is given in the table.

Table 5.3– Comparison of Nodal deflections

No. of Stories	Geometry	Model No.	Type of Slab	Max X (in mm)	Max Y (in mm)	Max Z (in mm)
8	Rectangle	RECT-08G	Waffle Slab	16.407	17.152	0.130
		RECT-08F	Flat Slab	14.016	12.405	0.315
	Pentagonal	PENT -08G	Waffle Slab	17.305	16.484	0.430
		PENT -08F	Flat Slab	19.955	13.015	0.369
	Octagonal	OCT-08G	Waffle Slab	37.254	0.710	0.384

		OCT-08F	Flat Slab	55.249	0.384	0.697
16	Rectangle	RECT-16G	Waffle Slab	39.183	15.430	0.603
		RECT-16F	Flat Slab	67.978	12.109	0.192
	Pentagonal	PENT -16G	Waffle Slab	38.254	41.019	0.597
		PENT -16F	Flat Slab	52.296	32.278	0.902
	Octagonal	OCT-16G	Waffle Slab	34.591	13.142	0.798
		OCT-16F	Flat Slab	63.429	19.719	1.970
24	Rectangle	RECT-24G	Waffle Slab	98.483	31.601	0.919
		RECT-24F	Flat Slab	151.705	37.482	0.384
	Pentagonal	PENT -24G	Waffle Slab	112.814	107.710	1.939
		PENT -24F	Flat Slab	177.680	135.732	2.974
	Octagonal	OCT-24G	Waffle Slab	255.703	98.451	1.807
		OCT-24F	Flat Slab	288.968	80.605	3.906

V. CONCLUSION

- ✓ Flat slabs in octagonal geometry give better results to other different models.
- ✓ The Flat Slabs resists more lateral loads in Pentagonal geometry. Thus the service life will be increases for Flat System.
- ✓ In Flat slab system there is more clearance height between two floors due to avoid of beams. Hence overall height of the structure will be reduces.
- ✓ Waffle Slab shows greater values of beam shear and beam moments compare with flat slab.
- ✓ The waffle slabs in Rectangular geometry sustain much load and moment in compared to other models.

VI. FUTURE SCOPE OF WORK

This analysis is done for zone-IV, and due to changing of the zone, the earthquake intensities will also be changed. Hence In such condition, the analysis can be done for other different zones. The analysis can be perform by using Conventional Slab, Flat slabs and waffle slab with using share wallsand also providing bracing system to resist earthquake hazard. For increase the effectiveness of the structure by earthquake hazards the shear walls, base isolation & bracing system can be used for analysis.

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